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In re Patent Application of:

Sung-hee HWANG et al.

Application No.: Unassigned | Group Art Unit: Unassigned

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For: METHOD AND APPARATUS FOR MANAGING DEFECTS IN RECORDING MEDIUM, A COMPUTER READABLE MEDIUM INCLUDING COMPUTER READABLE CODE FOR THE SAME, AND A DEFECT MANAGED RECORDING MEDIUM OBTAINED USING THE SAME METHOD, APPARATUS, AND COMPUTER READABLE MEDIUM

SUBMISSION OF VERIFIED TRANSLATION OF NON-ENGLISH LANGUAGE PROVISIONAL APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

The applicant(s) submit(s) herewith a copy of a verified translation of the following non-English language provisional application:

Provisional Application No. 60/472,121

Filed: May 21, 2003

It is respectfully requested that the English language translation of the non-English language provisional application be made of record along with the Utility application filed herewith.

Respectfully submitted,

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Date: March 15, 2004 By: _____

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IN THE MATTER OF

U.S. Provisional Application No. 60/472,121

By Samsung Electronics Co., Ltd

I, Eun-mee Won, an employee of Y.P.LE, MOCK & PARTNERS of The Cheonghwa Bldg., 1571-18 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare that I am familiar with the Korean and English language and that I am the translator of U.S. Provisional Application and certify that the following is to the best of my knowledge and belief a true and correct translation.

Signed this 7th day of August 2003

Eunmee Won

ABSTRACT

[Abstract of the Disclosure]

Provided are a method and apparatus for managing disc defects and a disc in which defect management is performed using the method and apparatus. The method includes (a) determining whether disc defect management ended successfully or not on a disc to be managed, (b) reading information regarding a defect from a most recently written replacement area on the disc and creating new defect information when it is determined that the disc defect management ended abnormally, and (c) updating defect management information with the created defect information. Accordingly, it is possible to restore data recorded in a defective area of a disc even if disc defect management on the disc ended abnormally.

[Representative Drawings]

FIG. 7

SPECIFICATION

[Title of the Invention]

METHOD AND APPARATUS FOR MANAGING DISC DEFECTS AND DISC THEREOF

[Brief Description of the Drawings]

FIGs. 1A and 1B illustrate the structures of a write once disc with a temporary defect management area (TDMA) and a defect management area, according to preferred embodiments of the present invention.

FIG. 2 is a block diagram of an apparatus for performing disc defect management, according to a preferred embodiment of the present invention.

FIG. 3 is a block diagram of a disc drive that includes the apparatus of FIG. 2.

FIG. 4 illustrates a data frame format.

FIG. 5 illustrates a disc spare area formed when disc defect management is abnormally terminated due to an unavoidable accident such as a power failure.

FIG. 6 illustrates diagrams explaining a method of restoring a spare bit map (SBM) which is a type of temporary management information.

FIG. 7 is a flowchart illustrating a disc defect management method according to a preferred embodiment of the present invention.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art Prior to the Invention]

The present invention relates to disc defect management, and more particularly, to a method and apparatus for performing disc defect management even in the case of a disc for which disc defect management was abnormally terminated, and a disc in which defect management is performed using the method and apparatus.

Disc defect management is the process of rewriting data stored in a user data area of a disc in which a defect exists to a new portion of the user's data area, thereby compensating for data loss caused by the defect. In general, disc defect

management is performed using linear replacement or slipping replacement. In linear replacement, the user data area in which a defect exists is replaced with a spare data area having no defects. In slipping replacement, the user data area with the defect is skipped and the next user data area having no defects is used.

Both linear replacement and slipping replacement are, however, applicable only to discs such as a DVD-RAM/RW, on which data can be repeatedly written and recording can be performed using a random access method. In other words, the linear replacement and slipping replacement are difficult to be performed on write once discs on which recording is allowed only once. In general, the presence of defects in a disc is detected by recording data on the disc and confirming whether or not data has been written correctly on the disc. However, once data is written on a write once disc, it is impossible to overwrite new data and manage defects on the write once disc.

The present applicant has filed other applications directed to a method and apparatus for managing disc defects on write once discs on which written data cannot be erased or rewritten, the method and apparatus being used in a disc drive, and a disc in which defect management is performed using the method and apparatus.

The disc defect management performed by a disc drive can be, however, abnormally discontinued due to an unavoidable accident, e.g., when a power supplied to the disc drive is interrupted due to a power failure.

[Technical Goal of the Invention]

The present invention provides a method and apparatus for performing disc defect management on a disc where disc defect management was abnormally terminated due to an unavoidable accident such as a power failure, and a disc in which defect management is performed using the method and apparatus.

[Structure of the Invention]

According to an aspect of the present invention, there is provided a method of managing disc defect, the method including (a) determining whether disc defect management ended successfully or not on a disc to be managed; (b) reading information regarding a defect from a most recently written replacement area on the disc and creating new defect information when it is determined that the disc defect

management ended abnormally; and (c) updating defect management information with the created defect information.

It is preferable that during (a), a consistency flag is checked to determine whether the disc defect management ended successfully.

It is preferable that (b) further comprises reading information regarding a position of the defect from the replacement area, reading information regarding a state of the defect from the replacement area, or creating new defect information based on previous defect information and the read defect information.

It is preferable that (c) further comprises recording new temporary defect information in a temporary defect management area (TDMA).

According to another aspect of the present invention, there is provided a method of managing disc defects, the method comprising (a) determining whether disc defect management ended successfully on a disc to be managed; (b) checking whether an area on the disc, which is recorded to contain no data in a most recently written space bit map (SBM), contains data by scanning the area when the disc defect management is determined to have been ended abnormally; and (c) updating the SBM to reflect a newly checked area containing data.

It is preferable that (c) further comprises recording the updated SBM as temporary management information in a TDMA.

According to another aspect of the present invention, there is provided a disc where a lead-in area, a data area, and a lead-out area are formed, the disc comprising a spare area formed in the data area and including a replacement area that substitutes for a defective area; a temporary defect management area (TDMA) that is present at least once in the lead-in area and the lead-out area and in which updated defect information is written at predetermined intervals of time; and a defect management area that is present at least once in the lead-in area and the lead-out area and in which most recently updated defect information written in the TDMA is written. Here, information regarding the defective area is written to the replacement area.

It is preferable that the information regarding the defective area contains information regarding the position of the defective area or information regarding the state of the defective area.

It is more preferable that the information regarding the defective area is written, together with data written in the defective area, in the replacement area.

Otherwise, it is more preferable that the information regarding the defective area is error correction code (ECC) encoded, together with data written in the defective area, and written to the replacement area. Otherwise, it is preferable that the ECC encoded data written in the defective area and information regarding the defective area are written to the replacement area.

According to yet another aspect of the present invention, there is provided an apparatus for managing disc defects, the apparatus comprising a pickup that writes/reads data to/from a disc; and a controller that determines whether disc defect management ended successfully on the disc by controlling the pickup to write /read data to/from the disc and checking a consistency flag, reads information regarding a defect from a most recently written replacement area and creates new defect information based on the read defect information, when it is determined that the disc defect management ended abnormally, and updates defect management information with the created defect information.

It is preferable that the controller reads information regarding the position of the defect from the replacement area or information regarding the state of the defect from the replacement area.

It is preferable that the controller creates the new defect information based on previous defect information and the read defect information and writes new temporary defect information in a TDMA.

According to still another aspect of the present invention, there is provided an apparatus for managing disc defects, the apparatus comprising: a pickup that writes/reads data to/from a disc; and a controller that determines whether disc defect management ends successfully on the disc by controlling the pickup to write/read data to/from the disc, checks if an area, which is recorded to contain no data in a SBM, contains data by scanning the area when it is determined that the disc defect management ended abnormally, and updates the SBM reflect a newly checked area containing data.

It is preferable that the controller records the updated SBM as temporary management information in a TDMA.

Hereinafter, preferred embodiments of the present invention will be described with reference to the accompanying drawings.

FIGs. 1A and 1B illustrate structures of a disc 100 according to preferred embodiments of the present invention.

FIG. 1A illustrates a single recording layer disc representation of the disc 100 having a recording layer *L0*. The disc 100 includes a lead-in area, a data area, and a lead-out area. The lead-in area is located in an inner part of the disc 100 and the lead-out area is located in an outer part of the disc 100. The data area is present between the lead-in area and the lead-out area. The start and end of the data area are the same as those of a CD rewritable (CD-RW), and the data area is sequentially divided into a spare area, a user data area, and a spare area, starting from the inner part of the disc 100. The user data area is an area where user data is written, and the spare areas serve to compensate for loss in the recording space of the user data area due to the defect. Since defects may occur on the disc 100, it is preferable that the sizes of the spare areas are determined such that a greater amount of data can be written on the disc 100. The positions of the spare areas are not fixed. At least one of a defect management area and a temporary defect management area is present in at least one of the lead-in area and the lead-out area.

FIG. 1B illustrates a double recording layer disc representation of the disc 100 having two recording layers *L0* and *L1*. A lead-in area, a data area, and an outer area are sequentially formed from the inner part of the first recording layer *L0* to its outer part. Also, an outer area, a data area, and a lead-out area are sequentially formed from the outer part of the second recording layer *L1* to its inner part. Unlike the single recording layer disc of FIG. 1A, the lead-out area is present in the inner part of the disc 100 of FIG. 1B. That is, the disc 100 of FIG. 1B has an opposite track path (OTP) in which data is written starting from the lead-in area of the first recording layer *L0* toward its outer area and continuing from the outer area of the second recording layer *L1* to its lead-out area. The spare area is allotted to each of the recording layers *L0* and *L1*.

In this embodiment, the spare areas are present between the user data area and the lead-out area and between the user data area and the outer area. If necessary, a portion of the user data area may be used as another spare area, that is, more than one spare area may be present between the lead-in area and the lead-out area.

FIG. 2 is a block diagram of an apparatus for performing disc defect management, according to a preferred embodiment of the present invention. Referring to FIG. 2, the recording apparatus includes a recording/reading unit 1, a controller 2, and a memory 3. The recording/reading unit 1 writes data on a disc

100 according to a preferred embodiment of the present invention, and reads back the data from the disc 100 to verify the written data.

The controller 2 performs disc defect management according to an embodiment of the present invention. In this embodiment, the controller 2 uses a verify-after-write method in which data is written on the disc 100 in predetermined units of data and the written data is verified to detect if an area of the disc 100 has a defect. More specifically, the controller 2 writes user data on the disc 100 in predetermined units of data, verifies the written user data to detect an area of the disc 100 in which a defect exists, and replaces a detected defective area with a replacement area. Thereafter, the controller 2 creates information that indicates the positions of the defective area and the replacement area and stores the created information in the memory 3. If the amount of the stored information reaches a predetermined level, the controller 2 writes the stored information in a temporary defect management area (TDMA) of the disc 100. Information written to the TDMA is called temporary management information *TDMS* corresponding to defect management information written to a defect management area (DMA). The temporary management information *TDMS* contains temporary defect information indicating the defective area and the replacement area, and temporary defect management information for managing the temporary defect information. In particular, in this embodiment, the temporary defect management information includes a space bit map (SBM) that provides information for differentiating available areas from unavailable areas of the disc 100.

The information regarding the defective area is written to the replacement area, so as to restore this information when temporary management information *TDMS* cannot be updated due to an unavoidable accident such as a power failure although the defective area has been replaced with the replacement area. The information regarding the defective area specifies the position and state of the defective area. For instance, information regarding a defective cluster is written to a new cluster, i.e., a replacement cluster, that is a substitute for the defective cluster. The information regarding the defective cluster specifies the position and state of the defective cluster. Disc defects include defects caused during recording of data and defects caused during verification of the written data. The position information regarding the defective cluster is considered address information. For instance, if several continuous physical sector numbers (PSNs) are allocated to the defective

cluster, a first PSN of the defective cluster is recorded as the position information thereof. The size of the position information is a unit of bytes so that all addresses of the disc 100 can be written as the position information. For instance, the position information may be about 4 bytes long. The state information regarding the defective cluster describes whether user data written in the defective cluster is equivalent to user data written in the replacement cluster, or describes whether the defect is a complete defect or an incomplete defect. The complete defect indicates data that is completely damaged and cannot be corrected, and thus cannot be read out, whereas the incomplete defect indicates data that has been corrected but is more likely to be damaged again. If the defect is the complete defect, data written in the replacement cluster may not be the same as data written in the defective cluster. This is because data, which is estimated to be written in the defective cluster, not the data that is actually written in the defective cluster, may be written in the replacement cluster when a complete defect occurs during recording of continuous data.

When a user presses the eject button (not shown) of the recording apparatus to remove the disc 100 after recording of data, the controller 2 expects the write operation to be terminated. Next, the controller 2 reads the defect information from the memory 3, provides it to the recording/reading unit 1, and controls the recording/reading unit 1 to write it to the disc 100. The temporary management information *TDMS* is updated for every write operation. Alternatively, the temporary management information *TDMS* can be updated whenever recording is completed in a predetermined record unit.

Also, the controller 2 sets a consistency flag when recording the temporary management information *TDMS* in the TDMA, in order to restore the temporary management information *TDMS* when the temporary management information *TDMS* is not updated due to an unavoidable accident such as a power failure although the defect area has been replaced with the replacement area. The consistency flag indicates the start of updating the temporary management information *TDMS*, in this case, the consistency flag is set to 1, for example. When the disc 100 needs to be removed from a disc drive after recording of data in predetermined units or after a write operation, the consistency flag may be reset to 0 so as to represent the successfully updating of the temporary management information *TDMS* while the temporary management information *TDMS* is finally

updated.

When recording in a next record unit starts or the disc 100 is reloaded, the controller 2 checks the consistency flag. If the consistency flag is 1, the controller 2 determines that the recording was abnormally terminated and starts restoration of the temporary management information *TDMS* and other additional information. That is, the controller 2 reads information regarding the defective area from a most recently replaced area, and updates the temporary management information *TDMS* and other additional information based on the read information. A detailed description thereof will be provided later.

When the recording of data is complete, i.e., additional data will not be written any more to the disc 100 (the disc 100 needs to be finalized), the controller 2 controls the recording/reading unit 1 to record most recently updated information in the DMA of the disc 100.

The information regarding a defective area is also written in a replacement area when a defect occurs during reproduction of data. For instance, the position information, e.g., a first PSN of a defective cluster, and state information regarding the defective are also written in a replacement cluster.

FIG. 3 is a block diagram illustrating the structure of a disc drive that includes the apparatus of FIG. 2. Referring to FIG. 3, the disc drive includes a pickup 10 that corresponds to the recording/reading unit 1 of FIG. 2. A disc 100 is loaded onto the pickup 10. Also, the disc drive includes a controller 2 that has a PC I/F 21, a digital signal processor (DSP) 22, a radio-frequency (RF) amplifier 23, a servo 24, and a system controller 25. A memory 3 is included in the system controller 25 of the controller 2.

During a write operation, the PC I/F 21 receives data to be written and a write command from a host (not shown). The system controller 25 performs disc initialization required for the write operation. The DSP 22 performs the error correcting code (ECC) encoding on the data transmitted from the PC I/F 21 by adding additional data such as data parity to the data, and modulates the ECC encoded data in a predetermined data format. The RF amplifier 23 converts the data output from the DSP 22 into an RF signal. The pickup 10 writes the RF signal output from the RF amplifier 23. The servo 24 receives a servo control command from the system controller 25 and performs servo control with respect to the pickup 10. Also, the system controller 25 instructs the pickup 10 to read the data from the

disc 100 or to record information such as temporary management information on the disc 100.

More specifically, the system controller 25 writes data in predetermined numbers of clusters and verifies the data written to the clusters. If a defect is detected in a cluster, the position information regarding the defective cluster and the state information regarding the defect are stored in the memory 3. When the data verification is complete or the defect is detected, the system controller 25 receives user data from the memory 3 containing the write command and user data transmitted from the host. The user data specifies the position of the defective cluster. Then, the system controller 25 incorporates the position information regarding the defective cluster and the state information regarding the defect into the user data and writes the user data to the replacement cluster.

During a read operation, the PC I/F 21 receives a read command from the host. The system controller 25 performs disc initialization required for the read operation. The pickup 10 illuminates a laser beam on the disc 100 and obtains and outputs an optical signal from the laser beam reflected from the disc 100. The RF amplifier 23 converts the optical signal output from the pickup 10 into an RF signal, provides data modulated from the RF signal to the DSP 22, and provides a servo signal, for servo control, obtained from the RF signal to the servo 24. The DSP 22 demodulates the modulated data, performs ECC encoding on the demodulated data, and outputs the ECC encoded data. The servo 24 performs servo control on the pickup 10, in response to the servo signal output from the RF amplifier 23 and the servo control command output from the system controller 25. The PC I/F 21 sends the data received from the DSP 2 to the host. Also, the system controller 25 may instruct the pickup 10 to read information regarding defect management from the disc 100 during the read operation.

More specifically, let us assume that an incomplete defect is detected during a read operation in response to a read command given from the host. In this case, when the system controller 25 determines there is sufficient time to make replacement for the incomplete defect after the read operation or even during the read operation, the system controller 25 reproduces user data from a defective cluster containing the incomplete defect, adds information regarding the defective cluster into the user data, and writes the user data in a replacement cluster. The user data written in the defective cluster and the information regarding the defective

cluster may be ECC encoded and written. Otherwise, only the user data is ECC encoded and written together with the information regarding the defective cluster.

Examples of methods of restoring data written in a defective cluster are as follows:

1. US Patent No. 6,367,049 discloses a method of recording data in an ECC format with an ECC cluster consisting of 304 long distance Reed-Solomon ECCs, and a burst indicator subcode (BIS) cluster consisting of 24 BISs. During making of the BIS cluster, a portion of control data may be allocated as a field to which information regarding defective clusters is written.

More specifically, in the recording data in the ECC format, when a defect is detected during a verifying process after the recording, user data written in a defective cluster containing the defect is read from a memory in response to a write command given from a host and is encoded into an ECC cluster. Next, control data with a physical address of the defective cluster is encoded into a BIS cluster in a portion of the control data, so as to make a physical cluster. Here, the portion of the control data is used as a field in which 16 physical addresses of a replacement cluster and information regarding the position and state of the defective cluster are written. Next, the physical cluster is written in a replacement cluster.

2, US Patent No. 6,367,049 teaches a method of recording in an ECC format when an incomplete defect is detected during a read operation in response to a read command given from a host, i.e., a defective cluster containing the defect can be replaced with a replacement cluster. The defective cluster is reproduced and errors in an ECC cluster and a BIS cluster are corrected so as to obtain user data. Next, the user data is encoded into an ECC cluster. Next, control data with a physical address and state information of the defective cluster are encoded into a BIS cluster in a portion of control data, thereby obtaining a physical cluster. Here, the portion of the control data is used as a field in which 16 addresses of the replacement cluster and information regarding the position and state of the defective cluster are written. Next, the physical cluster is written in the replacement cluster.

3. It is possible to perform disc defect management on DVD-RAM using a disc drive. Data is written in an ECC format using Reed_Solomon product codes

(RSPCs) (see the data format of a DVD-RAM specification). Therefore, the present invention is applicable to information storage media such as DVD-RAM and DVDs on which information can be recorded using RSPCs.

4. Information regarding the position and state of a defective cluster is stored in a linking area between record units of a disc when a defective cluster is replaced with a replacement cluster. To increase the reliability of data, the position and state information regarding the defective cluster is preferably written in an error correction structure in the linking area so that an error in the information can be easily corrected.

Hereinafter, a method of restoring temporary management information written to a temporary defect management area (TDMA) will be described.

FIG. 5 illustrates a disc spare area formed when disc defect management is abnormally terminated due to an unavoidable accident such as a power failure. Referring to FIG. 5, replacement clusters, which are substitutes for defective clusters, are written to a spare area. In general, replacements for defects are sequentially formed in the spare area, starting from a portion thereof with a smallest PSN. If necessary, replacements can be sequentially formed starting from a portion of the spare area with a largest PSN. The replacement clusters are divided into two types of clusters: clusters whose information is updated with temporary management information in a TDMS; and clusters whose information is not updated. Here, the updating of the replacement cluster information indicates that disc defect management was successfully completed. Replacement clusters whose information is not updated indicate that disc defect management was abnormally terminated and thus data written in the defective clusters have to be restored.

FIG. 6 illustrates diagrams explaining a method of updating a spare bit map (SBM) which is a type of temporary management information. In detail, FIG. 6(a) indicates a disc recording state described in a SBM of a disc 100 where disc defect management was abnormally terminated and restoration of data written in defective clusters is required, and FIG. 6(b) indicates the actual recording state of the disc 100. Here, black rectangles denote portions of the disc 100 that contain data, gray rectangles denote portions of the disc 100 that actually contain data but are indicated not to include the data in the SBM, and white rectangles denote portions of the disc

100 that contain no data. If the disc defect management abnormally ends, the SBM cannot reflect updated recording appropriately.

When the disc 100 is inserted into a disc drive, the disc drive checks a consistency flag. If the consistency flag is '1', the disc drive determines that the disc 100 was removed from a disc drive without successfully updating temporary management information written in a TDMA of the disc 100.

The disc drive scans a portion of the disc 100 containing no data, indicated in the SBM, and checks whether data is actually written in the portion, i.e., whether data is additionally written or not. In this way, the disc drive corrects the SBM to precisely reflect the recording state of the disc 100. As mentioned above, the SBM is a map that specifies a disc recording state with bit values, i.e., it indicates whether clusters, which are allocated to a physically recordable area of the disc 100, contains data or not. The disc drive scans all of clusters that are determined to have no data, specified in the SBM, checks if these clusters do not actually contain data, and makes a new SBM reflecting the checking result, i.e., it updates the previous SBM. When the updated SBM is written as temporary management information in the TDMA, updating of the SBM is complete.

FIG. 6(c) indicates a recording state of the disc 100, as specified in a new SBM that precisely indicates whether the clusters contain data or not. The disc drive makes the new SBM by updating the previous SBM with bit values.

FIG. 7 is a flowchart illustrating a disc defect management method according to a preferred embodiment of the present invention. Referring to FIG. 7, in action 701, when a write once disc on which disc defect management has ever been performed is loaded onto a disc drive, the disc drive reads temporary management information from a TDMA, stores the read information in a memory, and performs disc initialization required for a write/read operation. In action 702, if the loaded disc is not an empty disc, the disc drive reads a consistency flag set value *C_flag* from temporary defect management information contained in the temporary management information written to the TDMA, and determines whether defect information regarding the write once disc was successfully updated. For example, if the consistency flag is C_flag = 1, it means that the defect information was abnormally terminated, and if the consistency flag is C_flag = 0, it means that the defect information was successfully completed. If it is determined in action 702 that the defect information was not successfully updated, temporary defect information

contained in the temporary management information stored in the memory is read, the position of a most recently formed replacement area is detected, data written in a next replacement cluster is reproduced, and information regarding the position and state of a defective cluster is detected, in action 703. In action 704, a defect list naming the defective cluster and the replacement cluster is created based on the detected position and state information. In action 705, new defect information is created based on the created defect list and the previous temporary defect information. In action 706, the temporary defect management area is updated.

Examples of methods of restoring data contained in a defective cluster are as follows:

1. US Patent No. 6,367,049 discloses a method of recording data in an ECC format, in which a physical address of and information regarding a defective cluster are written in a replacement cluster during defect management. More specifically, a most recently updated replacement cluster is detected from a spare area of a disc, based on temporary defect information contained in defect management information. Next, data written in replacement clusters next to the detected replacement cluster is read. Next, an error in a BIS cluster of a replaced physical cluster is corrected. Next, defect lists naming defective clusters and replacement clusters are created by referring to the physical addresses and state information of the defective clusters, specified in control data. Next, new temporary defect information is created based on the defect lists and final temporary defect information that was read and stored in a memory when loading the write once disc onto a disc drive. Also, if data to be contained in the temporary management information exists and need to be updated, the data is also updated and written as temporary management information in the TDMA. The above method is applicable to write once discs and rewritable discs while changing particulars of data updating according to the characteristics of a disc used.

2. To restore data contained in a defective cluster of a DVD where data is written in an RSPC format and the physical address and state information of the defective cluster are written to a replacement block, first, a most recently formed replacement block is detected from a spare area of the DVD, based on temporary defect information contained in temporary defect information. Next, data written to

a next block is read and reproduced and an error in the data is corrected. Next, information regarding the positions and states of defective clusters written in a reserved area *RSV* shown in FIG. 4 is obtained, and defect lists naming the defective clusters and replacement clusters are created on the obtained information. Next, new temporary defect information is created, based on the defect lists and final temporary defect information that is read and stored in a memory when loading the DVD onto a disc drive. If data to be contained in the temporary management information exist and need to be updated, the data is again updated and written as temporary management information in the TDMA. The above method can be performed on both write once discs and rewritable discs while changing particulars of data updating according to the characteristics of a disc used.

3. To restore data written in defective clusters in a linking area containing information regarding the positions and states of the defective clusters, a most recently updated replacement block is detected from a spare area of a disc based on temporary defect information contained in temporary management information. Next, data regarding replacement clusters allotted to the replacement block is read from the linking area to obtain information regarding the positions and states of the defective clusters. Next, defect lists naming the defective clusters and replacement clusters are created based on the read information. Next, new temporary defect information is created, based on the defect lists and final temporary defect information, which is temporary management information, that was read and stored in a memory when loading the disc into a disc drive. If information to be added to the temporary management information exist and need to be updated, the information is updated and written as the temporary management information in a TDMA. The above method can also be performed on both write once discs and rewritable discs while changing particulars of data updating according to the characteristics of a disc used.

The above data restoration methods, i.e., recording for restoration of data or data restoration, are applicable both to write once discs and rewritable discs. However, the write once discs require a defect management area and a TDMA for disc defect management, whereas the inclusion of the TDMA into the rewritable

discs is optional. To be compatible with rewritable discs, it is recommended that the defect management area in he write once discs be equal to that of the rewritable discs, and most recently updated temporary management information written in the TDMA be written in the defect management area during disc finalization.

[Effect of the Invention]

As described above, the present invention provides a method and apparatus for restoration of temporary management information, especially; temporary defect information contained which is written to temporary defect management area (TDMA). According to the present invention, it is also possible to restore defect information written to a defect management area of each of rewritable discs. For instance, although replacement clusters have substituted for defect clusters caused during a write/read operation performed on a write once disc (or a rewritable disc), a disc may be removed from a disc drive without successfully updating of defect information in a TDMA/defect management area, due to an unavoidable accident such as a system power failure. Even in this case, according to the present invention, it is possible to restore temporary defect information/defect information written to the TDMA/defect management area. Also, it is also possible to restore a spare bit map (SBM) that fails to be updated.

In particular, the present invention is advantageously applied to a disc drive capable of checking whether a system is powered off. However, even if a disc drive cannot check whether a system is powered off, the present invention enables the disc drive to perform a write operation and restoration of data, in response to a host command or when a disc is loaded into the disc drive.

What is claimed is:

1. A method of managing disc defects, comprising:

(a) determining whether disc defect management ended successfully or not on a disc to be managed;

(b) reading information regarding a defect from a most recently written replacement area on the disc and creating new defect information when it is determined that the disc defect management ended abnormally; and

(c) updating defect management information with the created defect information.

2. The method of claim 1, wherein during (a), a consistency flag is checked to determine whether the disc defect management ended successfully.

3. The method of claim 1, wherein (b) further comprises reading information regarding a position of the defect from the replacement area.

4. The method of claim 1, wherein (b) further comprises reading information regarding a state of the defect from the replacement area.

5. The method of claim 1, wherein (b) further comprises creating new defect information based on previous defect information and the read defect information.

6. The method of claim 1, wherein (c) further comprises recording new temporary defect information in a temporary defect management area (TDMA).

7. A method of managing disc defects, comprising:

(a) determining whether disc defect management ended successfully on a disc to be managed;

(b) checking whether an area on the disc, which is recorded to contain no data in a most recently written space bit map (SBM), contains data by scanning the area when the disc defect management is determined to have been ended abnormally; and

(c) updating the SBM to reflect a newly checked area containing data.

8. The method of claim 7, wherein (c) further comprises recording the updated SBM as temporary management information in a TDMA.

9. A disc where a lead-in area, a data area, and a lead-out area are formed, the disc comprising:

a spare area formed in the data area and including a replacement area that substitutes for a defective area;

a temporary defect management area (TDMA) that is present at least once in the lead-in area and the lead-out area and in which updated defect information is written at predetermined intervals of time; and

a defect management area that is present at least once in the lead-in area and the lead-out area and in which most recently updated defect information written in the TDMA is written,

wherein information regarding the defective area is written to the replacement area.

10. The disc of claim 9, wherein the information regarding the defective area contains information regarding the position of the defective area.

11. The disc of claim 9, wherein the information regarding the defective area contains information regarding the state of the defective area.

12. The disc of claim 9, wherein the information regarding the defective area is written, together with data written in the defective area, in the replacement area.

13. The disc of claim 9, wherein the information regarding the defective area is error correction code (ECC) encoded, together with data written in the defective area, and written to the replacement area.

14. The disc of claim 9, wherein the ECC encoded data written in the defective area and information regarding the defective area are written to the replacement area.

15. An apparatus for managing disc defects, comprising:

a pickup that writes/reads data to/from a disc; and

a controller that determines whether disc defect management ended successfully on the disc by controlling the pickup to write /read data to/from the disc and checking a consistency flag, reads information regarding a defect from a most recently written replacement area and creates new defect information based on the read defect information, when it is determined that the disc defect management ended abnormally, and updates defect management information with the created defect information.

16. The apparatus of claim 15, wherein the controller reads information regarding the position of the defect from the replacement area.

17. The apparatus of claim 15, wherein the controller reads information regarding the state of the defect from the replacement area.

18. The apparatus of claim 15, wherein the controller creates the new defect information based on previous defect information and the read defect information.

19. The apparatus of claim 15, wherein the controller writes new temporary defect information in a TDMA.

20. An apparatus for managing disc defects, comprising:

a pickup that writes/reads data to/from a disc; and

a controller that determines whether disc defect management ends successfully on the disc by controlling the pickup to write/read data to/from the disc, checks if an area, which is recorded to contain no data in a SBM, contains data by scanning the area when it is determined that the disc defect management ended abnormally, and updates the SBM reflect a newly checked area containing data.

21. The apparatus of claim 20, wherein the controller records the updated SBM as temporary management information in a TDMA.